

Preliminary Occurrence Study of Cyanobacterial Toxins in Source and Finished Waters

James L. Sinclair

U.S. Environmental Protection Agency

Dr. Judy Westrick

Benjamin Southwell

Shelly Abbott

Sharla Wood

Lake Superior State University

Introduction

- Freshwater cyanobacteria may produce toxins
- During blooms, toxins concentrated enough to cause adverse health effects
 - Potential for occurrence in drinking water
 - Outbreaks from drinking water have occurred

Contaminant Candidate List

- Because of potential threat to drinking water, cyanobacterial toxins on EPA's drinking water Contaminant Candidate List (CCL) in 1998 and 2005
- CCL contaminants considered for regulation
 - sufficient information needed to make regulatory decision
- More occurrence information needed for cyanobacterial toxins

Occurrence Information

- Unregulated Contaminant Monitoring Rule (UCMR)- one year national survey of drinking water utilities
 - Planned for cyanobacterial toxins when methods available
- Preliminary occurrence information from small surveys helpful for designing UCMR
 - Conducted for algal toxins

Which Toxins to Monitor

- Specific toxins not listed on CCL
 - More than 80 total, too many to monitor.
- Expert workshop 2001 to pick high priority toxins in U.S.
 - Microcystins- 4- 6 common congeners
 - Cylindrospermopsin
 - Anatoxin-a

Preliminary Survey

- 2005
- Confidential
- 5 vulnerable utilities sampled
 - California
 - Oklahoma
 - Texas
 - Vermont
 - Florida

Preliminary Survey

- Weekly samples for 12 weeks May to August
- Raw intake water, finished water
- Microcystin, cylindrospermopsin, anatoxin-a
 - Microcystin- ELISA; 0.05 ppb detection limit
 - Microcystins (4 congeners), cylindrospermopsin, anatoxin-a- HPLC/PDA, 0.25 ppb detection limit
- Algal counts, identifications
 - Genera known to produce microcystin, cylindrospermopsin, anatoxin-a
 - Algal units (aggregations of cells) counted

California Utility

- Raw water
 - Toxins
 - Microcystin-
 - ELISA <0.05- 0.19 ppb;
 - HPLC/PDA all <0.25 ppb except 1 detect of 0.79 ppb
 - Cylindrospermopsin- <0.25 ppb
 - Anatoxin-a <0.25 ppb
 - Cell counts of toxin producers
 - 2 weeks- 350,000 algal units/mL
 - 10 weeks- 100- 1000 algal units/mL
- Microcystin not related to cell density
- Finished water- toxins not detected

Oklahoma Utility

- Raw water
 - Toxins
 - Microcystin-
 - ELISA <0.05- 0.13 ppb;
 - HPLC/PDA all <0.25 ppb except 1 detect of 0.90 ppb
 - Cylindrospermopsin- <0.25 ppb, except 1 detect of 0.41 ppb
 - Anatoxin-a <0.25 ppb
 - Cell counts of toxin producers
 - All counts- 100- 1000 algal units/mL
- Toxin concentrations not related to cell density
- Finished water- toxins not detected

Vermont Utility

- Raw water
 - Toxins
 - Microcystin-
 - ELISA <0.05 ppb
 - HPLC/PDA all <0.25 ppb
 - Cylindrospermopsin- <0.25 ppb
 - Anatoxin-a <0.25 ppb
 - Cell counts of toxin producers
 - All counts- <15 algal units/mL
- Finished water- toxins not detected

Texas Utility

- Raw water
 - Toxins
 - Microcystin-
 - ELISA <0.05 to 0.07 ppb
 - HPLC/PDA <0.25 ppb
 - Cylindrospermopsin- <0.25 ppb
 - Anatoxin-a <0.25 ppb
 - Cell counts of toxin producers
 - 50- 10,000 algal units/mL
- Toxin concentrations related to cell density
- Finished water- toxins not detected

Florida Utility

- Raw water
 - Toxins
 - Reservoir
 - Microcystin-
 - ELISA 0.05 to 0.17 ppb
 - HPLC/PDA <0.25 ppb
 - Cylindrospermopsin- <0.25 ppb
 - Anatoxin-a <0.25 ppb
 - River
 - Microcystin
 - ELISA 0.07 to 1.41 ppb
 - HPLC/PDA <0.25 ppb
 - Cylindrospermopsin <0.25 ppb
 - Anatoxin-a <0.25 ppb

Florida Utility

- Raw water
 - Cell counts of toxin producers
 - Reservoir
 - 22- 1300 algal units/mL
 - River
 - 800- 8000 algal units/mL
- Toxin concentrations sometimes related to cell density
- Finished water- toxins not detected

Summary

- The most common toxin detected in raw water was microcystin; cylindrospermopsin detected 1 time, anatoxin-a not detected.
- 1 raw water sample of 72 total had more microcystin than the WHO guideline level for drinking water of 1ppb of microcystin
- No toxins were detected in finished drinking water

Summary

- >2000 of toxin-producer algal units/mL in 3 of 5 sites in a total of 41 samples.
- Toxin concentration not always related to toxin-producer density
- Microcystin producers most common type of toxin producers
- Despite cell densities, no high levels of toxins.
- Small numbers of utilities surveyed may explain lack of high toxin levels.

Special Thanks

- The Volunteer Utilities
- The LSSU Chemistry Department
- Robin Root, Northern Kentucky Univ.
- Bonnie Newport, U.S. EPA
- Charles Feldmann, U.S. EPA
- Stewart Oherle, Northern Kentucky Univ.